

# Special Civil Engineer Examination

## Engineering Surveying Test Plan

### *Definition of Engineering Surveying*

**Engineering Surveying** is defined as those activities involved in the practice and application of surveying principles for the location, design, construction, and maintenance and operation of engineered projects.

This area of practice is structured into four primary content areas. The percentage given in parentheses represents the proportion of total test points that will address that test plan area.

- A. Engineering Surveying Equipment and Field Activities (20%)
- B. Engineering Surveying Field Measurements (10%)
- C. Engineering Surveying Calculations (40%)
- D. Engineering Surveying Office Procedures (30%)

### *Glossary of Engineering Surveying Terms*

As used in the test plan, the following abilities are defined as:

<b>Determine</b>	To establish or define after consideration, investigation, or calculation for use in an engineering surveying activity.
<b>Interpret</b>	To conceive and explain the meaning of engineering surveying terms, symbols, and procedures.
<b>Perform</b>	To execute and complete a task in accordance with the requirements of engineering surveying practice.
<b>Practice</b>	To offer engineering surveying services for or to carry out in action.
<b>Prepare</b>	To put together or make by combining various existing or newly created elements for use in an engineering surveying activity.
<b>Recognize</b>	To know or identify the engineering surveying elements of a project from past experience or knowledge.

**A.            ENGINEERING SURVEYING EQUIPMENT AND FIELD ACTIVITIES            (20%)**

Engineering surveying equipment and field activities include the types of equipment used and their application for gathering and interpreting field data and for construction layout.

**EA1            Recognize the purposes of different types of surveys.**

- EA1.1       Knowledge of general methods and procedures of control surveys
- EA1.2       Knowledge of general methods and procedures of construction surveys
- EA1.3       Knowledge of general methods and procedures of route surveys
- EA1.4       Knowledge of general methods and procedures of topographic surveys

**EA2            Determine the field survey instruments and equipment required to perform engineering surveying measurements.**

- EA2.1       Knowledge of the accuracy of measurements made with survey equipment
- EA2.2       Knowledge of the components and operation of an engineer's transit
- EA2.3       Knowledge of the components and operation of a total station
- EA2.4       Knowledge of the components and operation of leveling equipment such as:
  - level setup
  - self-leveling/automatic level
  - tilting level
  - leveling rods
  - laser leveling
- EA2.5       Knowledge of the components and operation of taping equipment such as:
  - plumb bob
  - hand level
  - tapes
- EA2.6       Knowledge of the components and operation of Electronic Distance Measurement (EDM)
- EA2.7       Knowledge of Global Positioning Systems (GPS) capabilities

**EA3            Practice within the laws regulating engineering surveying.**

- EA3.1       Knowledge of the scope of practice of engineering surveying as defined by the Professional Engineers Act (in contrast to the scope of practice of land surveying as defined by the Professional Land Surveyors Act)
- EA3.2       Knowledge of the Subdivision Map Act as it pertains to the practice of engineering surveying

- EA4 Recognize common construction surveying methods and procedures.**
- EA4.1 Knowledge of construction layout requirements to enable the contractor to construct the project
  - EA4.2 Knowledge of horizontal curve layout
  - EA4.3 Knowledge of horizontal and vertical control layout
  - EA4.4 Knowledge of line and grade layout
  - EA4.5 Knowledge of potential conflicts with underground utilities
  - EA4.6 Knowledge of location, orientation, and terminology for construction staking
  - EA4.7 Knowledge of offset distance computations
  - EA4.8 Knowledge of roadway layout
- EA5 Perform field surveying operations for a traverse survey.**
- EA5.1 Knowledge of closed traverse
  - EA5.2 Knowledge of open traverse
  - EA5.3 Knowledge of interior angle traverse
  - EA5.4 Knowledge of deflection angle traverse
  - EA5.5 Knowledge of radial traverse
  - EA5.6 Knowledge of angle-to-the-right traverse
- EA6 Perform field surveying operations for horizontal layout.**
- EA6.1 Knowledge of procedure for laying off angles
  - EA6.2 Knowledge of procedure for prolonging a straight line
  - EA6.3 Knowledge of procedure for establishing points on a straight line
  - EA6.4 Knowledge of procedure for locating a single point

**B.            ENGINEERING SURVEYING FIELD MEASUREMENTS**  
**(10%)**

Engineering surveying field measurements include the methods and procedures for determining distances, angles, and elevations.

**EB7            Perform the measurement of horizontal distances.**

EB7.1        Knowledge of standard taping procedures and techniques

EB7.2        Knowledge of procedures for measuring slope distances

EB7.3        Knowledge of the common types of taping errors and corrections such as:

- random
- slope
- temperature
- tension and sag

EB7.4        Knowledge of procedures for determining the horizontal distance along a slope, in increments (“breaking chain”)

EB7.5        Knowledge of Electronic Distance Measurement (EDM) procedures

**E8            Perform the measurement of angles.**

EB8.1        Knowledge of procedure for reading a vernier scale

EB8.2        Knowledge of procedures for measuring horizontal angles

EB8.3        Knowledge of procedures for measuring deflection angles

EB8.4        Knowledge of procedure for measuring vertical angles

EB8.5        Knowledge of the relationships between azimuths, bearings, back bearings, and angles

EB8.6        Knowledge of procedures for measuring angles by repetition

**EB9           Perform the measurement of elevations from leveling.**

EB9.1        Knowledge of procedures for differential leveling

EB9.2        Knowledge of definitions of leveling terminology such as:

- bench mark
- temporary bench mark
- turning point
- backsight
- foresight
- intermediate sight
- height of instrument

EB9.3        Knowledge of procedure for sighting the telescope and reading the rod

EB9.4        Knowledge of procedure for trigonometric leveling

EB9.5        Knowledge of procedure for cross-section leveling

EB9.6        Knowledge of procedure for profile leveling

**C.            ENGINEERING SURVEYING CALCULATIONS**

**(40%)**

Engineering surveying calculations are the analytical methods for applying the mathematical relationships between measured distances, angles, and elevations.

**EC10        Perform basic geometric and trigonometric calculations.**

- EC10.1      Knowledge of the properties of a right triangle
- EC10.2      Knowledge of general trigonometric formulas
- EC10.3      Knowledge of the properties of an oblique triangle
- EC10.4      Knowledge of trigonometric relationships to determine the area of a polygon

**EC11        Determine the properties of a horizontal curve.**

- EC11.1      Knowledge of the geometric properties and equations of a circular curve
- EC11.2      Knowledge of circular curve deflections
- EC11.3      Knowledge of procedures for locating a point on a curve
- EC11.4      Knowledge of procedure for calculating stations for the point of intersection, beginning of curve, and end of curve
- EC11.5      Knowledge of properties of compound and reversing curves
- EC11.6      Knowledge of procedure for calculating the intersection of a curve and a straight line

**EC12        Determine the properties of a vertical curve.**

- EC12.1      Knowledge of geometric properties and equations of a parabola
- EC12.2      Knowledge of procedures for calculating a vertical curve
- EC12.3      Knowledge of procedure for calculating vertical curves from tangent offsets of grade lines
- EC12.4      Knowledge of procedure for calculating intermediate points
- EC12.5      Knowledge of procedure for calculating the highest or lowest point
- EC12.6      Knowledge of procedure for calculating the rate of gradient
- EC12.7      Knowledge of procedure for calculating profile grade (slope) and elevations on the tangents

**EC13        Perform leveling calculations from field data to determine elevations.**

- EC13.1      Knowledge of procedure for running a line of levels
- EC13.2      Knowledge of procedures for checking level notes
- EC13.3      Knowledge of procedure for trigonometric leveling
- EC13.4      Knowledge of procedure for profile leveling

**EC14 Perform traverse survey calculations to determine point locations.**

EC14.1 Knowledge of procedures for calculating latitudes and departures

EC14.2 Knowledge of procedures for analyzing traverse closures such as:

- linear error of closure
- accuracy ratio
- closure correction

EC14.3 Knowledge of procedures for balancing a traverse

EC14.4 Knowledge of procedures for balancing field angles

EC14.5 Knowledge of procedures for calculating omitted measurements

**EC15 Perform error adjustment methods and procedures for surveying measurements.**

EC15.1 Knowledge of the types of surveying data errors

EC15.2 Knowledge of standard methods and procedures for error adjustments such as:

- leveling
- traverses
- distance measurements

EC15.3 Knowledge of the order of precision and level of accuracy of different survey types

**EC16 Perform rectangular coordinate system calculations.**

EC16.1 Knowledge of procedures for calculating distances from coordinates

EC16.2 Knowledge of procedures for calculating bearings or azimuths from coordinates

EC16.3 Knowledge of the following coordinate geometry relationships:

- intersection of line and a curve
- distance from a point to a line
- intersection of two straight lines

EC16.4 Knowledge of procedures for calculating an area from rectangular coordinates

EC16.5 Knowledge of the California State Plane Coordinate System

EC16.6 Knowledge of procedures for calculating plane coordinates

**EC17 Perform calculations to determine quantities of construction materials.**

EC17.1 Knowledge of methods for calculating volumes of materials

EC17.2 Knowledge of procedures for calculating volume by average-end-area method including using cross-sections

EC17.3 Knowledge of procedures for calculating volume by prismatic method

EC17.4 Knowledge of the purpose of mass diagrams

**D.                    ENGINEERING SURVEYING OFFICE PROCEDURES                    (30%)**

Engineering surveying office procedures include the research and planning for field surveys and the conversion of field data to an engineering format.

**ED18            Perform reduction of field data for plotting.**

ED18.1    Knowledge of the requirements and organization of field notes such as:

- leveling notes
- cross-section notes
- taping notes
- open and closed traverse notes

ED18.2    Knowledge of procedures for plotting profiles

ED18.3    Knowledge of procedures for plotting cross-sections

ED18.4    Knowledge of procedures for plotting field points and data

ED18.5    Knowledge of the applications of stationing

ED18.6    Knowledge of the relationship between grade lines and cross-sections

ED18.7    Knowledge of capabilities of electronic data recorders and data transfer methods

**ED19            Recognize information from legal boundary and easement data pertinent to engineering surveying projects.**

ED19.1    Knowledge of the U.S. Public Lands Survey System (Section, Township, and Range)

ED19.2    Knowledge of the standard formats and terminology of legal descriptions

ED19.3    Knowledge of the purpose of control monuments

**ED20            Recognize the use of datums for horizontal and vertical control.**

ED20.1    Knowledge of different types of horizontal datums such as:

- NAD 27
- NAD 83

ED20.2    Knowledge of different types of vertical datums such as:

- NGVD 29
- NGVD 88

ED20.3    Knowledge of the purposes and types of bench mark systems such as:

- Permanent
- Temporary

**ED21 Prepare topographic and planimetric maps.**

ED21.1 Knowledge of contour intervals

ED21.2 Knowledge of methods to plot contours from field information

ED21.3 Knowledge of methods for interpolating contours

ED21.4 Knowledge of methods and procedures for aerial photogrammetric mapping such as:

- photographic scale
- photographic overlap
- ground control requirements

**ED22 Interpret maps.**

ED22.1 Knowledge of map scales

ED22.2 Knowledge of common conventions of map orientation

ED22.3 Knowledge of standard map symbols

ED22.4 Knowledge of the characteristics and purposes of different types of maps such as:

- underground mapping
- topographic map
- municipal base mapping
- grading plans
- improvement plans
- subdivision map
- as-builts

ED22.5 Knowledge of the purpose of Geographic Information System (GIS)